

Two new *Eucyclops* species (Cyclopiformes: Cyclopidae) from Spain

Два новых вида рода *Eucyclops* (Cyclopiformes: Cyclopidae) из Испании

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Eucyclops miracleae sp. nov. from the Albufera Mediterranean lagoon, and *Eucyclops romaniensis* sp. nov. from a spring in the vicinity of Valencia, both from Spain, are described. These new species belong to the *serrulatus* group because of the structure of the antennula possessing a smooth hyaline plate on three distal segments and the antenna bearing a group of hair-like setae on the top of the anterior side of the antennal basis. The new species are clearly distinguishable from the type species of the genus, *E. serrulatus* (Fischer, 1851), by missing a gap between hair-like setae on the outer side of the P4 coxal spine. A key for *Eucyclops* species inhabiting surface and subterranean waters of Europe is given.

Описаны *Eucyclops miracleae* sp. nov. из средиземноморской солоновато-водной лагуны Альбуфера и *Eucyclops romaniensis* sp. nov. из родника в окрестности Валенсии в Испании. По конструкции и вооружению первых и вторых антенн (гладкая гиалиновая пластинка на антеннule и наличие волосоподобных щетинок на проксимальной стороне базиса антенн) новые виды относятся к группе *serrulatus*. От типового *E. serrulatus* (Fischer, 1851) они легко отличаются отсутствием характерного промежутка в волосках на наружном крае коксальной щетинки у четвертой пары плавательных ног. Для различия их среди других представителей рода *Eucyclops* приведен определительный ключ для всех известных видов из поверхностных и подземных вод Европы.

Key words: aquatic biodiversity, Iberian fauna, key, Europe, copepoda, *Eucyclops*, *Eucyclops miracleae*, *Eucyclops romaniensis*, new species

Ключевые слова: биоразнообразие, водные сообщества, фауна Иберийского полуострова, определительный ключ, Европа, веслоногие раки, *Eucyclops*, *Eucyclops miracleae*, *Eucyclops romaniensis*, новые виды

INTRODUCTION

Lake Albufera (Valencia area), the largest oligogaline coastal lagoon in Spain with several local endemic fish and decapods presents special interest for Iberian zoogeography (Dussart, 1964; Miracle, 1982). Recently a new cyclopid species *Eucyclops albuferensis* Alekseev, 2008 was described

from the vicinity of the lake (Alekseev, 2008). This study devoted to further taxonomical exploration of the cyclopoid fauna in the Albufera lake area. The main attention was paid to representatives of the genus *Eucyclops* from Europe and North America recently revised (Alekseev & Defaye, 2004; Alekseev et al., 2006).

MATERIAL AND METHODS

Lake Albufera ($39^{\circ}20'N$, $0^{\circ}20'W$) is located in the Valencia Community, north-eastern Spain. It is a shallow (1 m average depth), oligohaline (up to 2 g l^{-1}) and hypertrophic (chlorophyll 400 mcg l^{-1}) lagoon with a surface area about 20 km 2 . This lagoon was originally linked with sea but now the lake functions as a reservoir regulated by floodgates. Albufera Lake with surrounding lands that includes sand bars, springs and pine forest constitutes the Albufera Natural Reserve Park with restricted human activity that includes rice cultivation, sport fishing and ecological tourism.

Only two zooplankton species predominate in the lake community: a copepod *Acanthocyclops americanus* (Marsh, 1893) and a rotifer *Brachionus angularis* Gosse, 1851; phytoplankton of the lake is formed by cyanobacteria (Oltra & Miracle, 1992).

In January 2007 and in May 2008, three samples in the coastal area of the lake Albufera and one sample in a spring Villa Romane, connected with the lake, were collected. A handle net with mesh size 90 μm was used for filtering about 50 l of water. Samples were preserved with 85% alcohol or with 4% formalin.

The samples were sorted in the laboratory using a dissection Olympus microscope. Before the dissection, adult specimens were measured with an ocular micrometer (5 μm maximal resolution) and then photographed by a digital camera. After the dissection they were placed on slides in several drops of pure glycerol, covered with small cover glasses (10×10 mm), and surrounded with Canadian balsam. These slides than were observed with the maximal resolution 1000 (Plan objective 100, oil immersion) under compound microscopes Nikon and Zeiss Imager equipped with Nomarski optics and cameras lucida. Abbreviations used: END, endopodite; EXP, exopodite; BAS, basipodite, PI to PIV, swimming legs, PV and PVI, rudimentary legs, L/W, length/width ratio; ZIN, Zoological Institute, Russian Academy of Sciences, St. Petersburg.

TAXONOMIC PART

Order **CYCLOPIFORMES** Starobogatov, 1994

Family **CYCLOPIDAE** Sars, 1913

Genus ***Eucyclops*** Claus, 1893

***Eucyclops miracleae* sp. nov.**

(Figs 1A–H, 3A)

Holotype. Female, Spain: Lake Albufera, near Valencia, $39^{\circ}20.234'N$, $0^{\circ}20.147'W$; dissected in one slide, ZIN (Division of Freshwater Zoo-plankton) No. 55052.

Paratypes. Two females in glass tube conserved with formalin (4%) and glycerol (5%) mixture, ZIN (Division of Freshwater Zooplankton) No. 55053.

Description of holotype

Length measurements. Total body length without seta 1180 μm , with caudal seta 1665 μm . Prosoma 630 μm : cephalothorax 395 μm , 4 free thoracal somites: 65/90/50/30 μm . Urosoma 550 μm : genital double somite 170 μm , 3 following abdominal somites 80/80/80 μm , caudal rami 140 μm .

Body yellow-brown in colour. Cephalothorax as long as wide, with maximum width close to caudal side. Last thoracal somite with group of long hair-like setae at lateral margin. Genital double somite 1.1 times as long as wide with seminal receptacle as in Fig. 1A. Caudal rami slightly divergent, 5 times as long as wide, lateral margins with short saw of long teeth (10–12 teeth) with one third of proximal part and two third on dorsal surface. Terminal setae length proportion beginning from outermost setae: 1./5.89/8.95/1.32. Dorsal seta 0.5 and lateral seta 0.25 of outermost seta length.

Antennules 12-segmented, reaching middle of first free thoracal somite, last 3 segments with wide smooth hyaline membrane. Setation of segments beginning from the first one: 8/4/2/6/4/2/2/3/2/2/3/8. Antenna four-segmented, typical for genus.

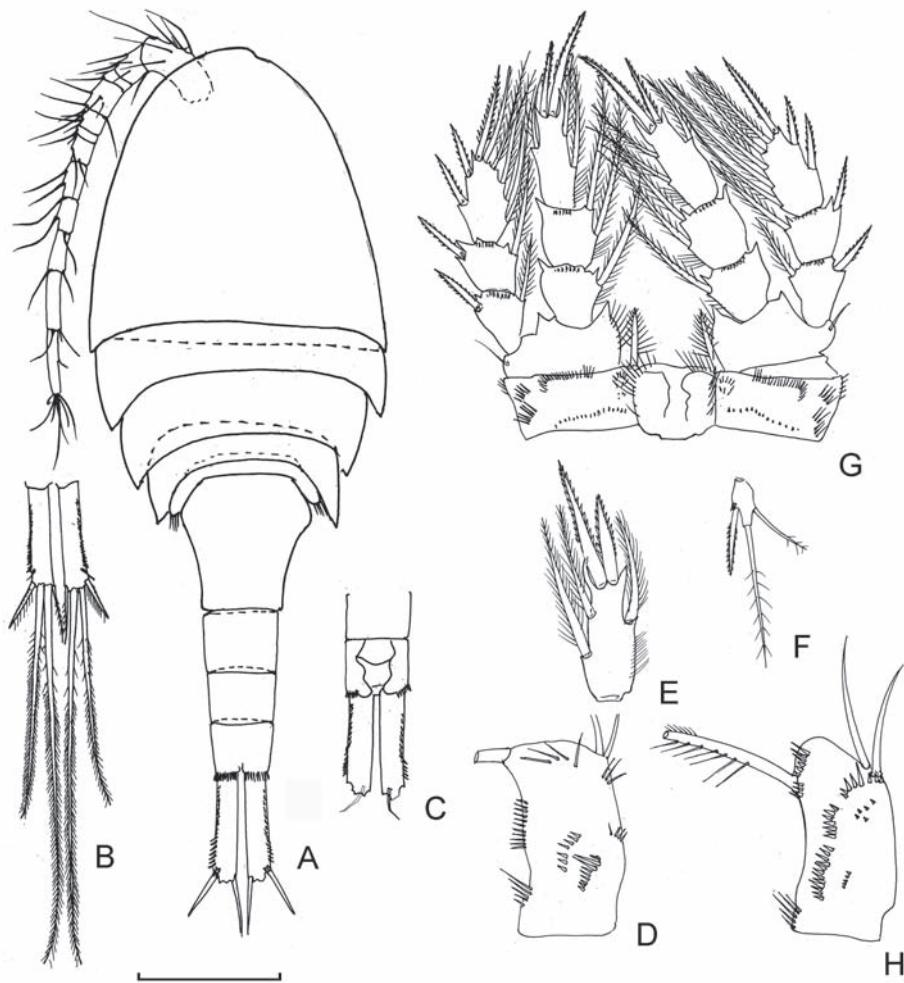


Fig. 1. *Eucyclops miracleae* sp. nov. A – body, ventrally; B – caudal rami, dorsally; C – caudal rami ventrally; D – P4, posterior side; E – endopodite of P4; F – P5; G, H – antennal base, posterior and anterior sides. Scale bar: 200 µm (A–C), 150 µm (D), 120 µm (E–F), 100 µm (G–H).

Antennal basis micro patterns: anterior surface with two sets of long hair-like spinules distally and laterally, with three parallel lines of spinules placed diagonally in central part, two groups of long spinules on right and two group of shorter spinules on left lateral sides; posterior surface with two long dents on top, with very wide spine-like process near lateral seta and group of long spinules in right distal part, 4–5 strong spinules in centre of distal part and with six groups of small spinules in central part as illustrated in Fig. 3.

Mandible with six teeth distally, rudimentary, endopod with two long setae and short seta. Maxilla comprising praecoxa with six strong teeth and two strong setae; two-segmented palp, distal article with three long hair-like setae and proximal article with four strong setae sub-equal in length and without spinules on lateral surface

Maxillula of four segments: praecoxa with two strong setae in middle; coxa with strong spine in middle, small seta and strong spine distally; basal endite with two very strong spines and small setae near place of

fusion of rudimentary endopodite, bearing two long spines, seta with long hairs and two hairless setae.

Maxillipeda of four segments: praecoxa+coxa with two strong setae in its middle part; basis with three setae of different length and group of strong spinules in middle near insertion of lateral seta; first segment of endopod with strong spine, rudiments of other endopod segments with strong spine and two hairless setae.

Swimming legs PI-IV with three-segmented rami; spine (Arabic numerals)—seta (Roman numerals) formula of EXP/END PI-IV as the following: 3V/1V-4V/1V-4V/1V-3V/2V. Distal spine EXP PIV about half of nearest seta and segment length. Distal segment END PIV 2.5 times as long as wide, inner distal spine 1.4 times as long as outer spine. Inner edge of basipodites PI to PIV with long hair-setae. Basipodite PI with relatively short inner spine reaching distal end of second segment of END. Intercoxal sclerite PI with high hills, row of small dents in middle part and without hairs on free edge. Intercoxal sclerites PII–III with hills on free edge and with groups of heart-setae. Intercoxal sclerite PIV as shown in Fig. 1.

Coxa PIV with strong spine bearing three or four dent-like spines in distal part and dense hair-setae in proximal part on inner sides and without hair-seta on most of outer side. Caudal side of coxa PIV with plenty of tiny spinules on inner side organised in groups and several groups of dents and hairs (Fig. 1).

Rudimentary leg PV with rather strong bent inner spine about twice of segment length, outer seta shorter than spine, middle seta about 1.2 times as long as spine

Egg sacs with 10–15 egg each.

Male unknown.

Etymology The species is named after Maria-Rose Miracle (University of Valencia, Spain) for her remarkable contribution to the knowledge of copepod ecology, zoogeography and biodiversity in Spain.

Eucyclops romanensis sp. nov.

(Figs 2A–D, 3B–C)

Holotype. Female, **Spain:** spring Villa Romane in Albufera Natural Park, 39°20.234'N, 0°20.364'W; dissected in one slide, ZIN (Division of Freshwater Zooplankton), No. 55054.

Paratypes. four females and two copepodite of five males in glass tube preserved with formalin (4%) and glycerol (5%) mixture, ZIN (Division of Freshwater Zooplankton), No. 55055.

Description of holotype

Length measurements. Abdomen 700 µm, that includes: cephalothorax 418 µm and four free thoracal somites 1/2/3/4 = 90/70/70/40 µm. Urosoma 400 µm, with genital double somite 110 µm, three following abdominal somites 1/2/3 = 65/60/55 µm and caudal rami 110 µm. Total body length without seta 1160 µm, with caudal seta 1655 µm.

Body almost transparent and colourless. Cephalothorax as long as wide, with maximum width close to middle. Last thoracal somite with group of hairs at lateral margin. Genital double somite 0.7 times as long as wide with seminal receptacle as in Fig. 3. Caudal rami slightly divergent, about 3.5 times as long as wide, lateral margins with very short saw between outermost and lateral seta; proximal group of saw teeth (4 or 5) slender but clear seen, to top of cauda saw teeth transformed into tiny spine not observed laterally (Fig. 3). Spine-like outermost seta and dorsal seta longer than innermost weak seta. Length proportions of terminal setae, beginning from the outermost seta: 1./5.5/10.9/0.95. Dorsal seta 1.1 and lateral seta 0.45 of length of outermost seta.

Antennules with 12 segments, reaching middle of first free thoracal somite, last three segments with narrow smooth hyaline membrane (Fig. 3). Setation of segments beginning from first one: 8/4/2/6/4/2/2/3/2/2/3/8. First six segments with rows of long hair-like setae on inner side of segments. Antenna four-segmented, typical for genus.

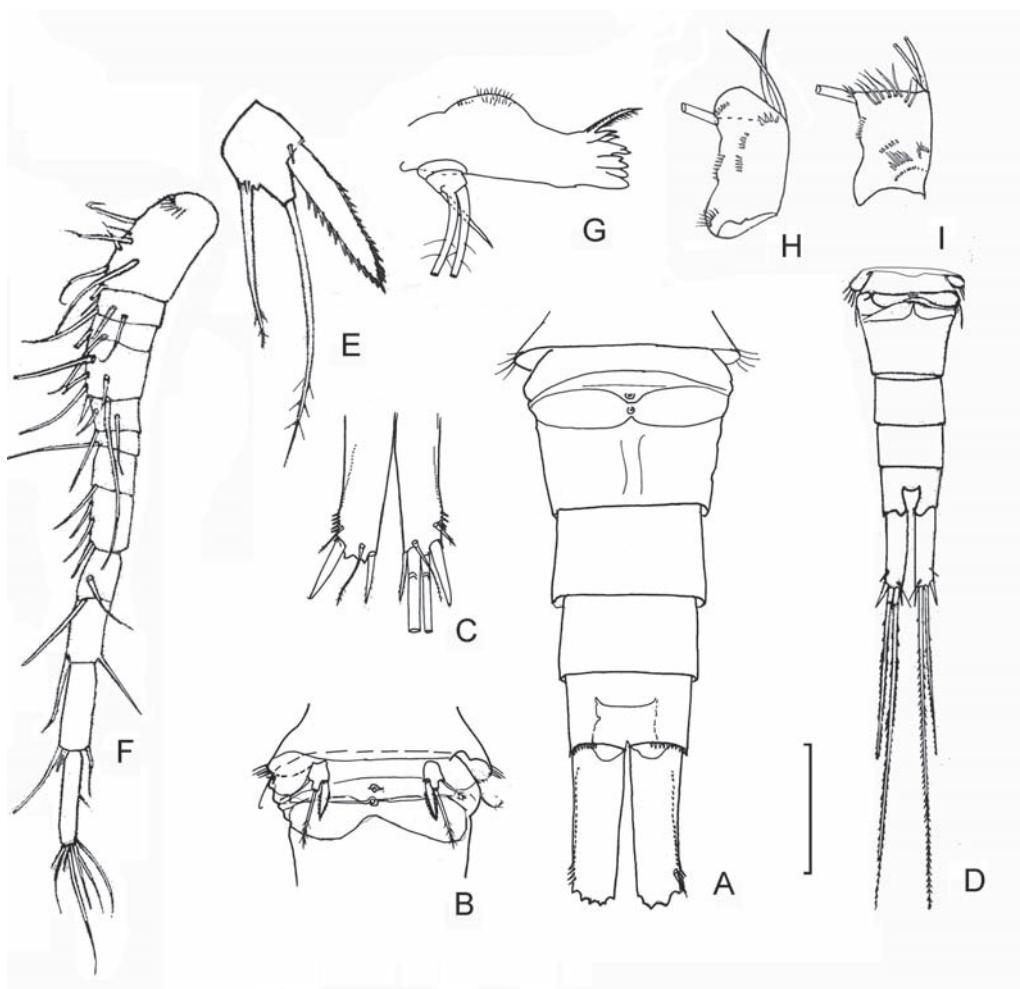


Fig. 2. *Eucyclops romaniensis* sp. nov. A – abdomen, dorsally; B – genital double somite, ventrally; C – caudal rami dorsally; E – rudimentary leg 5; F – antennule; G – mandible; H, I – posterior and anterior sides of antennal base. Scale bar: 100 µm (A–C), 75 µm (E–F), 50 µm (D, G–H).

Antennal basis micro patterns as follows: anterior surface with three sets of long hair-like spinules distally, laterally and in central part of segment, one group of shorter but hair-like spinules placed near long seta insertion place; in central part with three parallel lines of spinules placed diagonally, groups of long spinules on right and group of shorter spinules on left lateral sides; posterior surface with group of strong spinules in right distal part, four or five smaller spinules in left distal part and with two groups of five or six small spinules in central part (Fig. 2).

Mandible typical for genus. Maxilla typical for genus, palp without spinules on lateral surface. Maxillula four-segmented, typical for genus. Maxillipeda four-segmented: praecoxa+coxa with groups of seta-like spines close to setae insertion places; basis with group of strong spinules in the middle near the insertion of the lateral seta and lateral side of the segments.

Swimming legs three-segmented, spine (Arabic numerals)-seta (Roman numerals) formula of EXP/END PI–IV as below 3V/1V-4V/1V-4V/1V-3V/2V; all spines P1–P1V very wide and all setae in distal

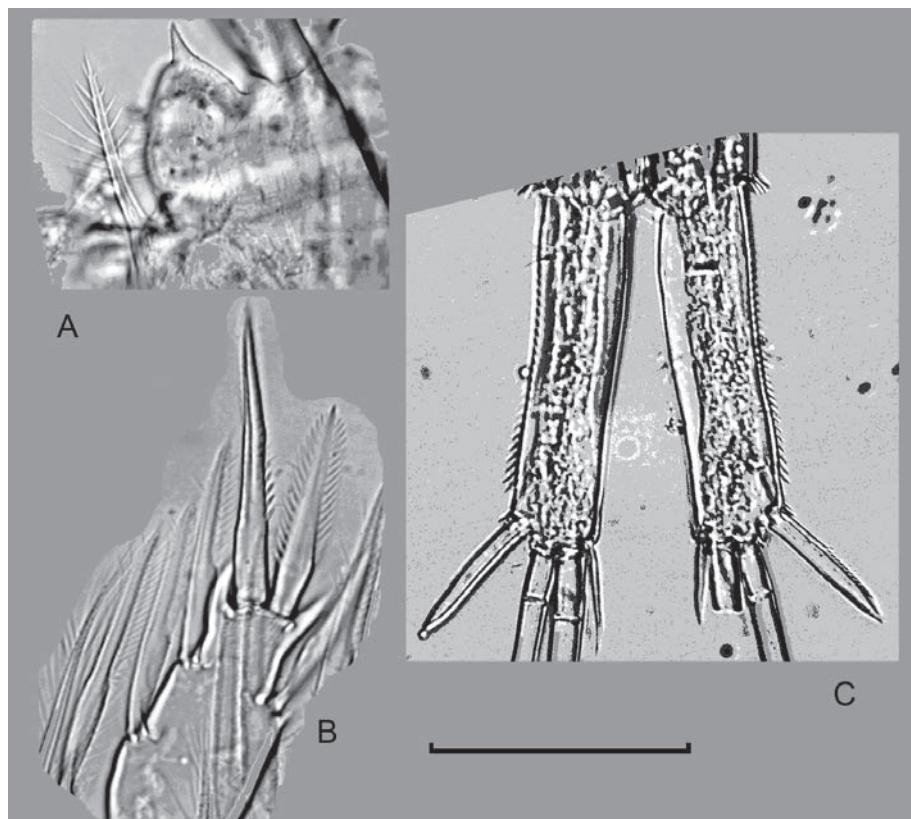


Fig. 3. Microphotographs, diagnostic characters. **A** – *Eucyclops miracleae* sp. nov., coxal spine P4; **B, C** – *Eucyclops romaniensis* sp. nov.: **B** – setae and spine on endopodite of P4; **C** – outer most and innermost setae in caudal rami. Scale bar: 80 µm (A, B), 100 µm (C).

part transformed in spines (Fig 3, B). Distal spine of exopodite PIV almost equal in length with nearest seta and distal segment. Distal segment END PIV 2.25 times as long as wide, with inner distal spine 1.4 times as long as outer spine. Inner edge basipodites PI–IV with long hair-setae. Basipodite PI with relatively long inner spine reaching distal end of 3d segment of END. Intercoxal sclerite PI with small hills, row of small dents in middle part and without hairs on free edge. Intercoxal sclerites PII–III with high hills on free edge and with groups of hair-setae. Intercoxal sclerite PIV with small hills and short rear hair-setae on its free edge, with two groups of long hair (Fig. 3).

Coxa PIV with relatively spine dense hair-setae on both sides. Caudal side of coxa PIV with plenty of tiny spinules on inner

side organised in groups and several groups of large dents and hairs (Fig. 3). Rudimentary PV with very strong wide fife-like inner spine, twice of segment length; outer seta slightly longer than spine, middle seta about 1.4 times as long as spine.

Egg sacs with 3–5 eggs each.

Male is unknown.

Etymology. The name of the species originates from the name of the type locality: a spring situated near historical ruins of the Rome time in the Valencia valley.

Taxonomic remarks

The new species, as they have the A1 with a smooth hyaline plate at the distal segments and the A2 basis with a group of hairs on the top of the anterior side,

belong to the *serrulatus* group (Alekseev et al., 2006). From the type species of the genus, *E. serrulatus* (Fischer, 1851), they are clearly distinguishable by lacking a gap at the outer side of the P4 coxal spine, by features of the micropatterns of the antennal basis and the caudal seta proportions. A key for *Eucyclops* species inhabiting surface and subterranean waters of Europe is given below.

Key to *Eucyclops* species recorded from Europe

1. A1 with 10–11 segments 2
- A1 with 12 segments 3
2. A1 with 10 segments, caudal rami long and smooth *E. orthostylus* Lindberg, 1953 (River Volga delta, possibly local or Ponto-Caspian endemic)
- A1 with 11 segments, innermost caudal seta hairless, distal part of apical setae of P4 transformed into spines *E. inarmatus* Kiefer, 1932 (caves in Slovenia)
3. Distal setae of P4 endopodite quite long, reaching behind ends of distal spines 4
- Distal setae of P4 endopodite short 5
4. Fifth somite without group of long hairs laterally, caudal rami long (more than 5 times as long as wide) parallel and almost smooth *E. graeteri* (Chappuis, 1927) (caves in Central Europe)
- Fifth somite with group of long hairs laterally, caudal rami short (less than 5 times as long as wide), divergent with short group of tooth in proximal part *E. subterraneus* (Graeter, 1907) (caves)
5. Last segment of antennules with smooth hyaline membrane 6
- Last segment of antennules with serrated hyaline membrane 12
6. Caudal rami with quite long row of spinules (serrula) laterally or on dorsal surface of rami 7
- External side of furcal rami with reduced row of spinules to 3–5 dents inserted near lateral seta; caudal rami slightly curved about 8–10 times as long as wide *E. macrurus* (Sars, 1863) (widely distributed in Palearctic)
7. A2 basipod with group of hairs on top of frontal side 8
- A2 basipod without group of hairs on top of frontal side 11
8. A2 basipod with two sets of long hairs on the top of frontal side; innermost seta longer than outermost seta 9
- A2 basipod with one sets of long hairs on the top of frontal side; innermost seta shorter than outermost spine-like seta *Eucyclops romaniensis* sp. nov (spring near Valencia, Spain)
9. Coxal spine P4 at outer side with clear seen gap in hairs 10
- Coxal spine P4 at outer side without gap in hairs, serrula with 8–10 long dents occupying only distal third of caudal rami. A2 basipod with two long dents in top row of caudal side, outermost caudal seta inserted distantly from other terminal setae *Eucyclops miracleae* sp. nov (Albufera Lake, Spain)
10. Serrula of caudal rami with 27–32 relatively small dents, longest dents never as long as half of rami width *E. serrulatus* (Fischer, 1851) (Palearctic)
- Serrula of caudal rami with 17–25 long dents, the longest dents as long as half of rami width *E. albuferensis* Alekseev, 2008 (lake in dunes, Albufera Natural Park, Spain)
11. Coxal spine P4 at outer side with clear seen gap in hairs, caudal rami 4–5 times as long as wide *E. leschermoutouae* Alekseev & Defaye, 2004 (wells in Balearic Islands, Spain)
- Coxal spine P4 at outer side without clear seen gap in hairs; caudal rami 6–8 times as long as wide *E. speratus* (Lilljeborg, 1901) (widely distributed in Palearctic)
12. Caudal rami short, L/W less than 3.5 *E. iblicus* Pesce & Galassi, 1987 (caves in Italy)
- Caudal rami long, L/W more than 4 13
13. External side of relative short (L/W 5–7) caudal rami with partly reduced row of spinules that occupies two third of its distal part 14
- External side of elongated (L/W 7–9) caudal rami with well developed row of spinules 15
14. Inner spine P5 very long, almost equal to outer seta *E. longispinosus* Pesce & Galassi, 1987 (cave in Italy)
- Inner spine P5 short, almost equal to segment length and at least half of outer seta length *E. denticulatus* (Graeter, 1903)

15. Caudal rami clear bent, inner spine of P5 strong and straight
..... *E. macruroides* (Lilljeborg, 1901)
(widely distributed in Palaearctic)
- Caudal rami parallel, inner spine of P5 weak and bent *E. porrectus* Kiefer, 1932
(endemic of Lake Ohrid)

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REFERENCES

- Alekseev, V.R.** 2008. *Eucyclops albuferensis* sp. nov. (Cyclopidae: Copepoda: Crustacea) from Albufera lake, Valencia, Spain. *Proceedings of the Zoological Institute RAS*, **312**: 127–134.
- Alekseev, V. & Defaye, D.** 2004. *Eucyclops lessermoutouae* sp. nov. from Mallorca, Balearic Islands (Crustacea, Copepoda: Cyclopoida). *Zoosystematica Rossica*, **12**: 163–169.
- Alekseev, V., Dumont, H., Pensaert, J., Baribwegure, D. & Vanfleteren, J.** 2006. A re-description of *Eucyclops serrulatus* (Fischer, 1851) (Crustacea: Copepoda: Cyclopoida) and some related taxa, with a phylogeny of the *E. serrulatus*-group. *Zoologica Scripta*, **35**: 123–147.
- Dussart, B.** 1964. Copepodes d'Espagne. *Bulletin de la Société Zoologique de France*, **89**: 117–125.
- Miracle, M.** 1982. Biogeography of the freshwater zooplanktonic communities of Spain. *Journal of Biogeography*, **9**: 255–467.
- Oltra, R. & Miracle, M.** 1992. Seasonal succession of zooplankton populations in the hyper-trophic lagoon Albufera of Valencia (Spain). *Archiv für Hydrobiologie*, **124**: 187–204.

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